Offshore Wind Power Development in China: Impacts and Management

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Abstract

Energy is one of the most important components to maintain the normal operation of a society. Overconsumption of fossil fuels caused plenty of negative influences on the environment, and both humans and animals are suffering from those. However, the renewable energy transition is often described as a dual political and economic challenge. As the largest energy consumer and carbon dioxide emitter, the Chinese government has put forward the concept of carbon peak and carbon neutrality. To achieve these goals, developing offshore wind power becomes a potential avenue. This paper compared Chinese offshore wind power with that in Europe to find the gap between them to further people's understanding of the impacts and management of offshore wind power in China. Therefore, using literature review to summarize and synthesize the ideas created by previous authors and identify gaps in knowledge that this paper research can address. Then, using the SWOT method to analyze the strengths, weaknesses, opportunities, and threats of the development of offshore wind power in China and conclude with some suggestions. Based on the problem that the paper mentioned, there are some suggestions. First, the government in China could apply policies broadly, reserving a range of offshore wind power policies. Second, it is necessary to research and develop offshore wind power subsidies per region in light of the circumstances there. Third, strengthening innovation and focus on solving core technologies. After solving current problems, the management of offshore wind power in China will be more sustainable.

Keywords

Offshore wind power; Energy; SWOT analysis; Government; China; Europe

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Introduction

The global economy is fueled by energy (Liko, 2019). From heating homes to powering factories, energy has been the basis and driving force behind the progress of human civilization. A future of violent storms, floods, droughts, wildfires, and unbearably high temperatures is predicted as all climate indicators continue to smash records (Guterres, 2022).

However, as the primary sources of societal energy for a very long time, coal and oil have come to dominate human society. The inherent disadvantages and unique qualities of fossil fuels have had a significant negative impact on the environment globally and put the continued advancement of human society in jeopardy. One of the most crucial worldwide challenges of the modern era is the gradual replacement of fossil fuels. The essence of the energy revolution is the replacement of the main energy source and the upgrading or change of energy production and consumption mode. The energy revolution will spur social main body technological group innovation and support a paradigm shift in economic development (Lu, 2021). Droege argued that by 2030, the world's energy consumption will have increased by 60% to 85%, taking into account both the global energy crisis and the threat of climate change (Droege, 2008). It is therefore becoming more and more obvious that renewable energy will be a crucial pillar of future economic growth. Achieving an energy transition involves more than just switching energy sources; it also involves making sure that it is affordable, sustainable, and development-friendly. Currently, the development of offshore wind power has received unprecedented attention as an effective way to achieve sustainable energy security and at the same time combat climate change (Zhang et al., 2018). Offshore wind power is the process of capturing wind energy at sea, turning it into electricity, and supplying it to the onshore electrical grid (Nikitas et al., 2020).

Governments around the world have vigorously strengthened and implemented their energy and climate policies, but no commitment is more important than China's commitment. As the world's largest energy consumer and carbon emitter, China emitted 10.2 billion metric tons of carbon dioxide in 2019, almost twice as much as the United States (5.3 billion metric tons), and about 28 percent of total worldwide emissions (Steinwehr, 2021) (See **Figure 1**). However, the government promised that China aims to become carbon peak by 2030 and carbon neutrality by 2060 (Zhao, 2020). which will significantly boost other nations' confidence in combating climate change. The pledges made by China have served as an example for other developing nations and have increased pressure on developed nations that have not yet made carbon neutrality commitments (Zhao, 2020).

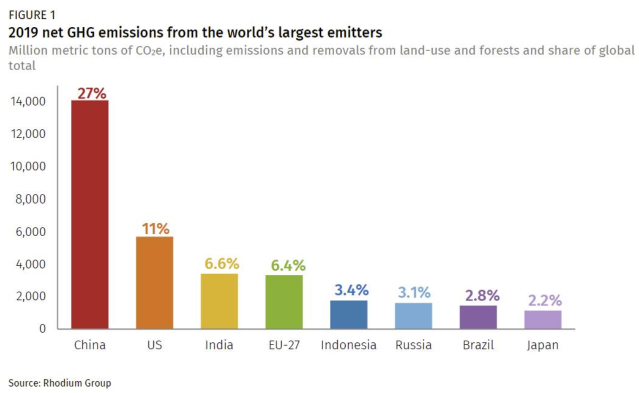


Figure 1. China accounts for 27% of global CO2 emissions and a third of global greenhouse gas emissions in 2019

Source: China's Greenhouse Gas Emissions Exceeded the Developed World for the First Time in 2019Larsen et al., 2021

China has accumulated a wealth of experience in developing onshore wind power, which has increased competitiveness with other conventional power generation (See Figure 2)

(Statista Research Department, 2022). Offshore wind power in China has a relatively advanced wind farm plan. However, as society has grown, the earlier planning idea and the demands of the present have diverged significantly. The previously mentioned plan is not ideal, so there is still a large gap to becoming a mature system (He et al., 2018).

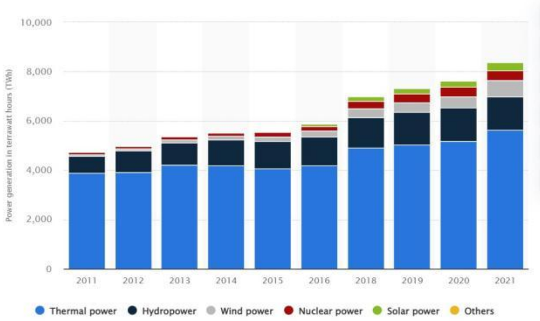


Figure 2. Electricity generation in China from 2011 to 2021, by source (in terawatt hours).
Source: Statista Research Department, 2022

From a world perspective, wind power is the fastest-growing and one of the most promising renewable energy sources for large-scale development and commercial development. Developed countries with long coastlines e.g. the United Kingdom, Japan, Denmark, and the United States support the development of offshore wind power through tax incentives, production and consumption subsidies, and other policies, and have identified offshore wind power as an important energy source in the future.

From China's perspective, firstly, to reach the objective of carbon peaking and carbon neutrality, energy systems are suggested to be transformed (Economic Information Daily, 2021). Thus, it is necessary for China to develop wind power. Since the wind blows faster offshore than on land, offshore farms provide more electricity per installed capacity. offshore power generation has less impact on people and the environment than on land (Martins, 2020). Developing it actively has a significant effect on reducing carbon emissions and is an effective means to achieve carbon neutrality. Secondly, from the economic point of view, at present, the energy supply and demand of China are in reverse distribution. In terms of resources (including new energy resources), China's energy supply and demand are currently distributed in the opposite direction, with abundant resources and low demand in the western region and poor resources and high demand in the east region. Geographically speaking, the coastal region benefits from being adjacent to the sea and easy commercial trade with other nations. It has emerged as the region with the greatest economic development, and its GDP has always made up more than 60% of the national GDP (National Bureau of Statistics).

Compared with onshore wind power, the key difference of offshore wind power is the occupation of marine space resources. Quality space for the installation of onshore wind turbines is becoming increasingly scarce and offshore wind power is becoming increasingly attractive due to several advantages such as large deployment areas, more stable wind speeds, and proximity to load centres (Lu et al., 2013). However, it can be expensive and challenging to construct and manage offshore wind farms. More specifically, it can be highly expensive to manufacture and install cables under the water to transmit power back to shore (Rourke et al., 2010). As for the environment, the scale of development and construction of offshore wind farms is large, and the construction period and operation period of the projects will have a certain impact on the marine ecological environment. For instance, birds, fish, marine mammals, and plankton will be affected. Economically, it is necessary to pay attention to the wastefulness caused by wind power abandonment due to the large regional differences in marine environmental resources.

The following will provide an overview of the current situation of ocean power generation in China. Although China became the country with the most newly added and accumulated installed capacity of the sea and land wind power in 2021 (Global Wind Report 2022), ocean power generation, in general, remains the same problem.

Knowledge about offshore wind power is relatively limited. It is an emerging technology-intensive industry, with related equipment vulnerable to strong winds, seawater corrosion, and waves. R&D capabilities and engineering strength are insufficient to support the sustainable development of offshore wind power. Offshore wind power involves many industries and sectors, and there are gaps in macro coordination and integrated planning at the national level, which will seriously affect future sustainable development.

There is also a lack of in-depth research on the economic and life-cycle technical and economic evaluation of offshore wind power industry development (Science and Technology Daily, 2019). As a result, the development of offshore wind power in China faces the dual challenge of establishing a technical policy system and promoting technological innovation (Zhang et al., 2018).

The rest of the paper is as follows: the second part puts forward the theory based on the review of relevant literature. The third part constructs the SWOT analysis method to find some development strategies; The last part is the discussion and conclusion, which discuss the development of offshore wind power in China, concludes the whole paper, and gives suggestions. This study extends previous research on the environmental and economic challenges in the development of offshore wind power in China.

Background of China and the European Union

The total installed offshore wind capacity reached 57.2 GW by the end of 2021, an increase of almost 60% year over year globally, with China accounting for 48%, the UK for 22%, and Germany for 13%. In terms of newly installed capacity, offshore wind power represented 21.1 GW globally in 2021, accounting for 22.5% of the total newly installed capacity worldwide (Wang et al., 2022). In 2021, China was responsible for 80% of new offshore wind installations, while the UK was responsible for 11% (See Figure3).

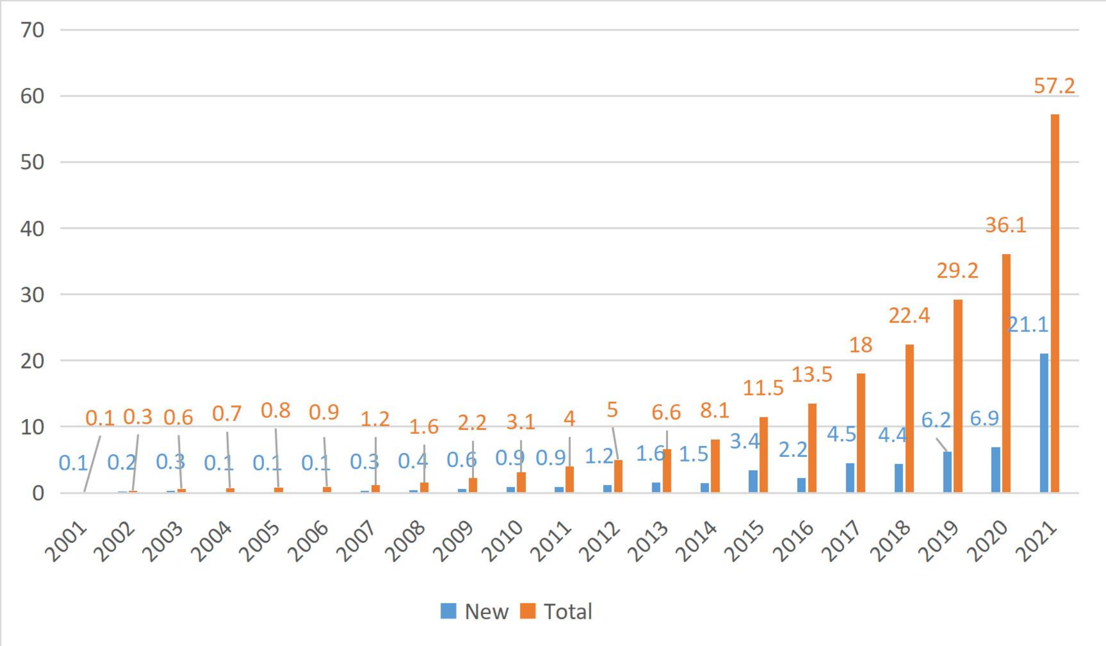


Figure 3. Over the last 20 years, offshore wind power installed capacity has changed globally. The X-axis represents the year and the Y-axis represents offshore wind power installed capacity (gigawatts). Source: Experience and Enlightenment of Parity network of offshore Wind Power in typical European countries - National Development and Reform Commission (Wang et al., 2022)

China is a country with a monsoon climate, so there are ample resources provided for offshore wind power generation. Besides, the eastern of China borders the sea, as the most economically developed region in China, provinces, and cities in the east offer a sizable market for the extensive development of offshore wind power (Qianzhan Industrial Research Institute, 2019)

The China National Energy Administration divides wind farms into onshore and offshore wind farms. Mudflat wind farms in the subtidal and intertidal zones, inshore wind farms, and deep-sea wind farms are all examples of offshore wind farms (See Table 1).

Table 1: Types of offshore wind farms.

Types of offshore wind farms	Location
Mudflat wind farms in the intertidal and subtidal zones	At the theoretically lowest water level in the coastal areas, in sea areas below the typical high tidal line, in a depth of up to five meters.
Inshore wind farms	those built on islands without permanent occupants, and reefs inside the associated marine areas, in the seas with a 5 to 50 m water depth below the theoretically lowest water level.
Deep-sea wind farms	those built on islands without permanent occupants, reefs within the corresponding sea areas, and sea areas having a water depth of at least 50 meters below the theoretically lowest water level

Source: Development of offshore wind power in China (Chen, 2011)

Offshore wind farms, in the intertidal and subtidal zones, mudflat wind farms are those that are built in sea areas below the typical high tidal line in up to five meters of water depth at the theoretically lowest water level in coastal locations. Inshore wind farms are those built-in sea areas with a water depth of 5 to 50 meters below the theoretically lowest water level, including those built on uninhabited islands and reefs in the corresponding sea areas. Deep-sea wind farms are those built in sea areas where the water is at least 50 meters (m) below the theoretically lowest water level. These include wind farms built on reefs and islands devoid of permanent habitation (Chen, 2011).

China's coastal regions have two different types of wind energy resources. The first is the wind-energy-abundant belt within the coastal regions and the nearby islands. The second is the wind-energy-abundant areas inshore. However, the actual offshore wind power resource capacity that can be produced in the sea area within 5-20 meters of seawater depth on the east coast of China is much less than that on land due to the restrictions of marine services such as ship routes, ports, aquaculture, etc. Offshore wind can be a crucial clean energy source for the future growth of these regions because Guangdong, Fujian, Jiangsu, and Shandong have a wealth of offshore wind resources and are adjacent to significant power consumption centers.

Offshore wind power development in China is still in its early stages. When compared to onshore wind power, offshore wind power development offers both prospects and challenges (Zhao and Ren,2015). China's offshore wind power has the characteristics of stable offshore resources and large power generation, it has developed rapidly in recent years and has broad market prospects. Offshore wind power in China has formally started to develop since 2007. The 100MW Donghai Bridge offshore wind farm was linked to the grid in 2010, making it the first large-scale offshore wind farm in China and Asia (Gong, 2020). In 2017, The total number of offshore wind power connected to the grid reached 2GW, ranking third in the world (Gong, 2020) (See Figure 4). China became the country with the largest accumulative offshore wind power installations in 2021 (Rajgor, 2022) and the newly installed offshore wind capacity reached 16.9GW (Weekes & Richard, 2022).

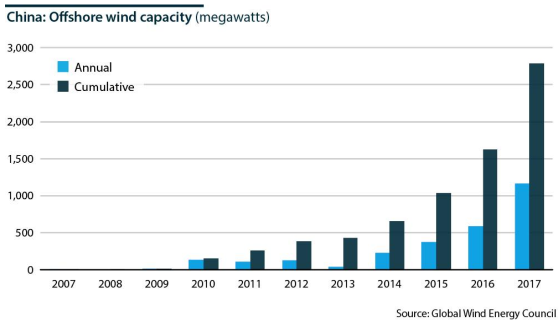


Figure 4. Annual and Cumulative offshore wind capacity(megawatts) in China from 2007 to 2017. The X-axis represents the year and Y-axis represents offshore wind capacity (megawatts).
Source: Offshore wind takes off in China and Taiwan (Global Wind Energy Council, 2018)

In contrast, Europe has a relatively long history of using offshore wind power than China. The years 2002 and 2011 were the commercial development phase in Europe, with expanded construction, accelerated technological innovation, and strong policy support. 2002 and 2011 witnessed the Commercial development stage and it is characterized by the expansion of the construction scale, the acceleration of technological innovation, and strong policy support. Then, from 2012 to 2019, large-scale development and technological progress have driven rapid cost reduction, and Europe has taken the lead in entering the era of unsubsidized parity. By the end of 2019, Europe lead the development of offshore wind power with a cumulative installed capacity of offshore wind power that made up 75% of the global installed capacity(Gong, 2020).

The EU has always been a leader in the development and deployment of renewable energy technologies, especially in offshore wind. However, China has gradually become the global leader in installed renewable energy capacity. It is necessary to compare the key issues of wind energy cost, technology research, and management between China and the EU to provide a basis for the next analysis (Crijns-Graus et al., 2022)

Cost Comparison Between China and European Union

Cost reduction is still an inevitable trend in the offshore wind industry (Li, 2019).

Around 2010, China's offshore wind power enjoyed subsidies and began large-scale development, so offshore wind power in China has developed quickly (Li, 2020). However, according to a police regulation jointly released by relevant departments in China, new offshore wind power projects do not be covered by government financial incentives after 2021. Therefore, 2022 is a crucial turning point in the development of China's offshore wind power industry because of the loss of central financial incentives (Li, 2020). The development prospects for offshore wind generation are unclear in the absence of transparent local government policy (Wang et al., 2022). China's domestic 'load rush' from 2019 to 2022, limited the reduction in average construction and operating costs of projects, but cost reduction is still an inevitable trend in the offshore wind industry

In terms of the EU, the offshore wind power industry adopted a fixed price support policy in the early stages of development, which is an important guarantee for promoting the stable and orderly development of the industry. This is evident from the process of grid parity for offshore wind in typical European countries. For instance, the major components of the UK's wind power strategy are contract-for-difference fixed prices and renewable energy requirements. To guarantee adequate returns from offshore wind generation, Germany, on the other hand, adopts a differential initial energy price implementation period policy.

Development Goals of China and European Union

Except for the subsidy, using larger and more efficient turbines is the key to lower costs and electricity prices (Danish Wind Energy Briefing, 2016). Because increasing the capacity of individual wind motors minimizes the necessary base of the draught fan, and fewer wind turbines are needed to produce the same amount of electricity (Danish Wind Energy Briefing, 2016).

Between 2005 and 2013, China’s government implemented several measures to boost offshore wind power R&D. Since offshore wind power turbine R&D was included in the 2005 development guiding catalog for the renewable energy sector of China’s government, it was clear that China's government had begun to place more emphasis on offshore wind power. China began to conduct technical research and development, experiments, and pilot offshore wind power demonstrations from 2006 to 2010. In recent years the government has promoted offshore wind power technology development and manufacture.

The European Commission released a draft strategy SET-Plan. The European Union's 2008 adoption of the SET-Plan is the first step toward creating a European energy technology policy. It serves as the main decision-making tool for

European energy policy with the objectives of accelerating knowledge development, and technology uptake, maintaining EU industrial leadership in low-carbon energy technologies, fostering science for transforming energy technologies to achieve the 2020 Energy and Climate Change goals, and assisting in the global transition to a low carbon economy by 2050 (European Commission, n.d.).

In 2020 to set offshore wind power targets for the following 30 years to meet the 2050 "net-zero emissions" target. The proportion of renewable energy in the entire EU's energy consumption will increase from its present level to 38%–40% by 2030. Rapid expansion in the offshore wind industry is anticipated to necessitate an extra €789 billion in investments while also adding about 62,000 new jobs. EU policies will prefer traditional fixed offshore wind generation over innovative floating offshore wind turbines (China Energy Network, 2020).

The development of "offshore renewables" will be a focus of the European Union's 2030 targets, which have been set. The EU intends to use 60 gigawatts of tidal and wave power by 2050 while expanding the total installed capacity of offshore wind power to 30 gigawatts (China Energy Network, 2020).

China's offshore wind power industry started relatively late. With the introduction of foreign advanced technology and government policy guidance and support, the installed capacity has continued to grow rapidly, gradually narrowing the gap with the mature market in Europe.

Approval of Offshore Wind Projects

There is a gap between European countries and China regarding offshore wind power management. In China, a variety of approvals from the marine and maritime ministries are required before China's offshore wind-generating projects may be approved. These approvals include marine environmental assessments, sea area use demonstrations, navigation safety assessments, etc. In some circumstances, it is also required to get advice from the planning and land departments about the choice of planning sites and the pre-examination of land. The lengthy approval process, intricate processes, and challenging coordination that go into the approval of offshore wind generation projects increase opportunity costs (Wang et al., 2022).

In Europe, the development of the European wind industry has been significantly hampered by laborious government approval procedures, the complicated project examination and approval process, and poor enforcement of the EU's "renewable energy development guide" in member states. These issues have made the development of the European wind industry one of the main challenges. Besides, Over the past few years, wind-generating projects have encountered a variety of challenges in Europe, including protests in France, Germany, and Belgium (Li, 2022).

Project Management

The development of offshore wind power in China is of great significance. The introduction of a series of major strategies such as "carbon peak and carbon neutrality" has ushered in significant opportunities for the development of the offshore wind power industry (Yang, 2021).
Looking to the future, people need to encourage intensive development, and optimization of layout, combined with the advancement of technology, cost reduction of industrial clusters, and policy innovation, to accelerate the promotion of rapid cost reduction. And pelagic aspects could layout several significant offshore wind projects, while simultaneously improving the associated management and mechanism

(Yang, 2021).

The development of offshore wind power includes improving the management and policy framework for the industry. To ensure the development of offshore wind power, the state will offer policy direction and local governments will offer policy assistance. China is better to keep advancing regional and national support policy studies (Yang, 2021).

One of the leading-edge initiatives of the European energy technology strategy is the SET- Plan. The strategy has two key goals including enhancing project benefits and construction of infrastructure, where the former is lower average electricity costs for the stationary offshore wind farm's FID (final investment decision), and the latter can be used in deeper oceans, as well as the development of integrated wind power systems that are cost-competitive.

The plan will prioritize actions on nine measures, including but not limited to the development of offshore wind power, ecosystem, and social impact assessment, and the industrialization of wind power technologies, to accomplish these aims. The administration hopes to lower the average price by implementing these measures under the premise of enhancing the efficiency and dependability of offshore wind systems. Future offshore wind power development will also depend on rising social acceptance and wise space planning. On the other hand, innovation and pertinent scholarly research will both be significant. It is anticipated that nations in the European North Sea region would work hard to achieve these objectives and establish a viable new offshore wind market.

Project Integration

The wind turbines generate electricity at sea, and the bottom piles of the wind turbines can be used to develop sea ranches since the distribution of wind energy resources in offshore China overlaps with the areas needed for marine farming. China currently has no such integration projects in place, only pilot development projects and projects under construction.

However, European countries, such as Germany, the Netherlands, and Norway, carried out pilot studies on the combination of offshore wind power and marine aquaculture in 2000 (Gao, 2021). Thus, China needs to learn from European countries to improve the supporting facilities for offshore wind power, accelerate its development, and form a model that can promote sustainable development.

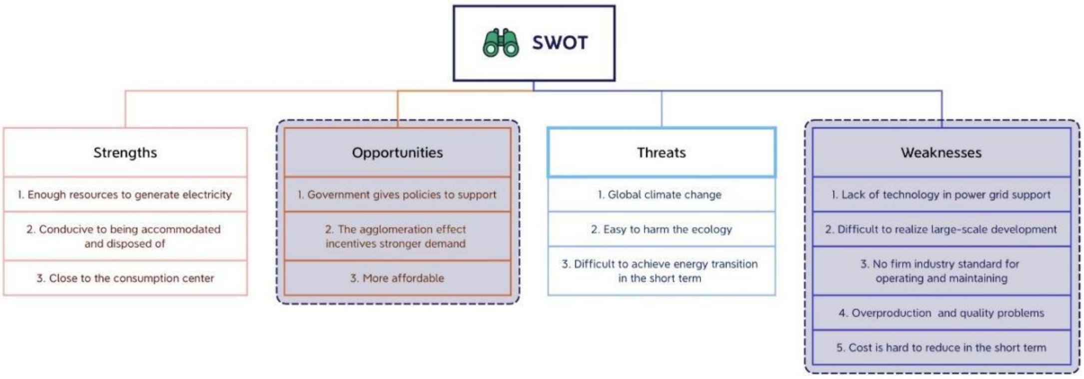
The SWOT analysis for offshore wind power development in China

A prominent method for assisting in determining a practice's or organization's strategic direction is the SWOT analysis. It is recommended for the current study since it provides insightful data on the system under consideration's long-term viability (Panigrahi & Mohanty, 2012).

This paper applied SWOT to offshore wind power. Because this type of energy will experience extraordinary development potential as a new trend in wind energy development. Offshore wind power development is still in its early stages, and there are numerous difficulties and dangers to be aware of. Following a comparison of offshore wind power with onshore wind power, the SWOT analysis will be used to examine the internal strengths, weaknesses, and external opportunities and threats of offshore wind power (Zhao & Ren, 2015).

The SWOT analysis of this paper (See Table 3).

Table 3. The SWOT analysis



Strengths

Compared with European offshore wind power and onshore wind power, China's offshore wind power has its unique advantages. China is a country with a monsoon climate. The difference in the thermal properties of land and sea results in distinctive winter and summer wind characteristics and abundant wind resources. Furthermore, China has the tenth longest coastline in the world at 14,500 km (Nag, 2020), providing the sea area available for offshore wind turbine installations. Compared to onshore wind power, offshore wind power is not only close to load centres (See **figure 5**) (Zhao & Ren, 2015) but also does not take up land resources, making it the preferred choice for renewable energy development in the eastern coastal regions.

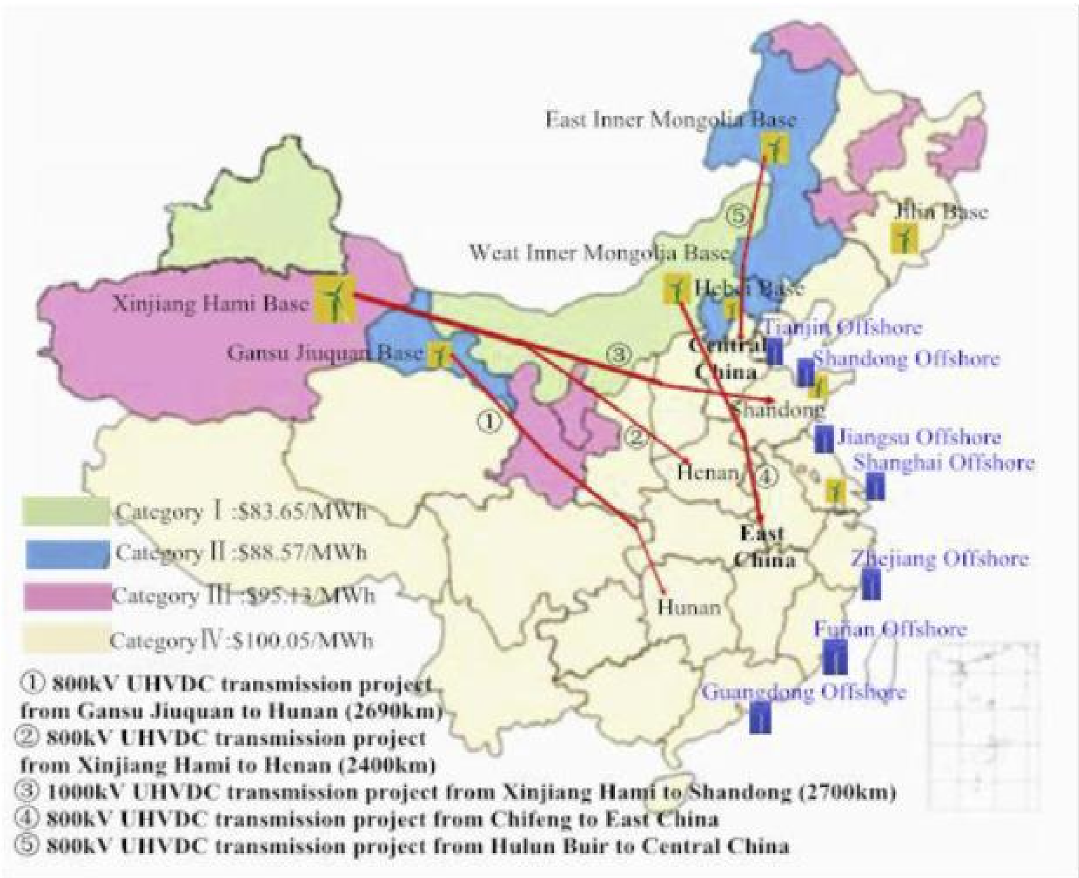


Figure 5. Wind power ultra-high voltage (UHV) transmission planning schemes.
The east of China is experiencing rapid economic development and strong demand. As can be seen from the figure, offshore power generation is closer to the eastern region, while road power generation is far away from the eastern region.
Source: Focus on the development of offshore wind power in China: Has the golden period come? (Zhao & Ren, 2015)

Weaknesses

Compared with Europe, technical issues are internal weaknesses. In the aspect of power grid support, the technology of accepting large-capacity wind power has not yet made a breakthrough. And China's producers have a lot of wind equipment's key technologies that they still don't truly grasp, so it is difficult to realize large-scale development of offshore wind power (Zhao & Ren, 2015). And there is not yet a firm industry standard for operating and maintaining offshore wind turbines. The wind turbine's remote problem diagnostic and early warning system is not ideal, and maintenance is challenging due to the unfavorable maintenance environment (Fu, 2020). There is little room for cost reduction in the short term, and wind turbines are facing overproduction and quality problems (Yao, 2019).

Opportunities

After President Xi promised carbon neutrality, the government gave policies to support offshore wind power development.
With the improvement of infrastructure and the increase in personnel training, China's offshore wind power has produced an agglomeration effect. The cost of offshore wind power has been reduced as previously mentioned, so there will be more chances to use offshore wind power in production processing (Danish Wind Energy Briefing, 2016)

Offshore wind power is becoming more affordable as scale increases. The global offshore wind industry's Levelized cost of electricity (LCOE) was 1.56 CNY in 2014; it was 0.79 CNY in 2017; and it reached 0.57 CNY in the second half of 2021 (Wang et al., 2022).

Threats

Global climate change will cause more extreme natural disasters, such as typhoons, heavy rains, and lightning, which can destroy wind turbines, causing economic losses and environmental damage. The marine ecosystem is complex, making it simple to harm the ecology while locating offshore wind farms (Draget, 2014). China has used coal and other high-carbon energy sources for a long time, but offshore wind power is only in the initial stage. Thus, it is difficult to achieve energy transition in the short term (Zeng et al., 2021).

Discussion and Conclusion

The aforementioned internal strengths and weaknesses, as well as external opportunities and dangers, can be summarized as expansion strategy (SO strategy), turnaround strategy (WO strategy), diversification strategy (ST strategy), and defensive strategy (WT strategy). As a result, these may examine the strategic development strategy that China could use depending on the situation.

The SO strategy presents opportunities to match with other industries, such as tourism. Because infrastructure drives integration with other industries and offshore wind power is close to energy consumption centers. Thus, there will be plenty of demand plus the relevant government support policies could boost other industries around offshore wind power. By promoting democratic decisions on the location of offshore wind power, and making full use of indigenous and traditional knowledge to reduce costs in other processes. The WO strategy overcomes internal weaknesses to increase growth opportunities. The government can stimulate technological innovation and reduce the cost of offshore wind power through supporting policies, such as increasing subsidies and encouraging innovation, to achieve large-scale development. In addition, the government can introduce macro policies as soon as possible to control the development of the offshore wind industry and reduce overproduction and quality problems. Policy promotion and technical support are the main elements of the ST strategy. China's offshore wind power relies heavily on imports of foreign offshore wind turbines, but climate differences, such as typhoons in the southeast, have led to higher engineering costs for Chinese offshore wind turbines than in Europe (Gao, 2020). Therefore, the introduction of offshore wind turbines in China needs to be accompanied by "localised" design breakthroughs, through more efficient project approvals and technical routes to make offshore wind turbines more reliable and less costly to adapt to China's natural and economic conditions (Gao, 2020). WT develops the strategy of defense plan. Make use of scientific and technological innovation to reduce ecological damage. In addition, the government should have good macro-control, so that domestic enterprises can have more communication with their foreign counterparts, to avoid a wider technological gap.

The government in China could apply policies broadly, reserving a range of offshore wind power policies. Many nations have adopted offshore wind power as a key approach for future energy development, which is consistent with the trend of global energy development. The use of offshore wind power will become more and more significant in China's shift to green energy. It is advised to apply broad policies to stabilize the development of offshore wind power in light of the high cost of new projects and the challenge of obtaining affordable Internet connectivity. Additionally, tax breaks and financial subsidies should be made stronger, and initiatives to assist innovation can be taken to promote the introduction of a range of offshore wind power regulations. To enable businesses to access the Internet at a reasonable cost, the appropriate policy combinations will be promptly established based on the development scenario and stage features of offshore power generation (Wang et al., 2022).

It is necessary to research and develop offshore wind power subsidies per region in light of the circumstances there. The cost of offshore wind generation is significantly influenced by marine environmental conditions. The distribution of offshore wind resources in China is more challenging than in European nations because different provinces are faced with varying levels of wind resources and because the underwater development environment varies greatly. These variations have an impact on both the daily operation and maintenance expenses of offshore wind power as well as the building and installation costs. Additionally, the type of subsidies will depend on the different quantities of fiscal revenue and the different ability to accommodate and process power in various regions. Therefore, subsidy policies should be formulated according to local conditions (Wang et al., 2022).

Strengthening innovation and focus on solving core technologies. A key wind turbine is the core equipment of offshore wind power, and its performance and reliability determine the investment return of wind farms to a large extent. By improving the operation stability of wind turbines, enhancing the independent innovation capacity of key technologies and core components of wind turbines, concentrating on key issues of offshore wind power, accelerating the localization of offshore wind power equipment, and lowering the cost of wind turbine manufacturing, operation, and maintenance. It is recommended to use the national renewable energy fund or to provide specific financial subsidies to encourage offshore wind power research and development to lower the risk associated with independent company research and development and lower the development costs. To increase the overall competitiveness of the business, offshore wind power companies may also be offered specific tax benefits (Wang et al., 2022).

Nevertheless, there may some dissenting voices since offshore wind power links to many aspects. Developing this kind of energy affects the ecological environment under the sea. Construction of offshore wind farms leads to seafloor habitat destruction. The disruption of sand and silt from the seafloor results in sediment suspension in the water column. By boosting turbidity, releasing contaminants, and suffocating animals that feed on sessile suspensions, like corals and sponges, sediment suspension is likely to hurt the fauna. The photosynthesis of algae can be impacted by a decrease in visibility caused by sediment suspension, and visual animals' essential behaviors may be affected (Baker, 2020). Offshore wind power makes noise pollution which can cause either temporary or permanent hearing damage to animals. Sharks and rays and other animals that use electroreception to detect prey or conspecifics may be affected by the electromagnetic fields created by the transportation of the acquired energy through electric cables buried in the seafloor (Baker, 2020).

This paper has discussed the impacts and management of offshore wind power development in China. There are some gaps between offshore wind power development in China and European countries be found. As for the approval of offshore wind projects, there are too long and complicated procedures in China which reduce efficiency. Additionally, China is lack macro project management and mature project integration. However, China has been working hard to close the gap with European countries. The government has introduced many supporting policies and given subsidies as well to incentive technology innovation. In the meantime, the government also strengthens the management of offshore wind power projects, by making detailed development plans from provinces to countries. This paper has provided insight into the environment and background of offshore wind power and aims to further the understanding of the impacts and management of offshore wind power in China. The current information highlights the importance of developing offshore wind power sustainably both in the environment and economy and it is crucial for the government to realize the carbon peak and carbon neutrality goals by developing this sort of energy because the UN's Sustainable Development Goals need to be achieved by 2030. The goals mentioned that people should find affordable clean energy, to ensure access to affordable, reliable, and sustainable modern energy for all. Therefore, this is the research significance of this paper.

Several limitations need to be noted regarding the present study. This paper focuses mainly on the environment and the economy and cannot be fully summarized all the aspects. Further studies need to be carried out for more detailed inspection and to give more specific coping strategies.

Conflict of Interests: the author has claimed that no conflict of interests exists.

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